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THE FUNCTION OF THE "WINGS" OF *PTEROSAGITTA DRACO*
AND THE SO-CALLED TANGORECEPTORS IN
OTHER SPECIES OF CHAETOGNATHA¹⁾

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With 3 Text-figures

In 1949 while studying live chaetognaths, I often touched them with a bristle and observed that although they were very sensitive to touch on the body surface, the so-called tactile tufts or tangoreceptors were insensitive to gentle rubbing, to strong, rapid stroking and to jabbing. Since then I have had several opportunities to repeat this simple experiment and have tested seven or eight species including *Eukrohnia hamata*. In all cases the results were the same, no response from touching the "tactile" tufts, immediate response from touching the tail fin or the body surface.

On October 24, 1965 at eleven a.m., while swimming in shallow water in Tanabe Bay, I saw several species of Chaetognatha including *Flaccisagitta enflata*, *Parasagitta robusta*, and *Serratosagitta pacifica*. One short stout individual with large seminal vesicles looked like *Pterosagitta draco*. I was able to catch it in a plastic bottle and in the laboratory confirmed the field identification of the still living, perfect specimen.

I took this opportunity to repeat my earlier observations on its especially long "wings". When the tufts were bent back and forth with a needle, the arrowworm didn't show the slightest response. However, the gentlest touch to the tail fin evoked a powerful swimming reaction. Other parts of the body such as the trunk and head were somewhat less sensitive to touch than the tail, as in the other species tested earlier. It seems clear that the hair-like bundles or tufts as well as the "wings" are not tactile sensory structures. Apparently GEGENBAUR (1856) first suggested they were tactile after study of their structure. BURFIELD (1927) called them tactile organs and this has since been repeated many times in the literature—see HYMAN (1959, p. 22) for example.

1) Contributions from the Seto Marine Biological Laboratory, No. 451.

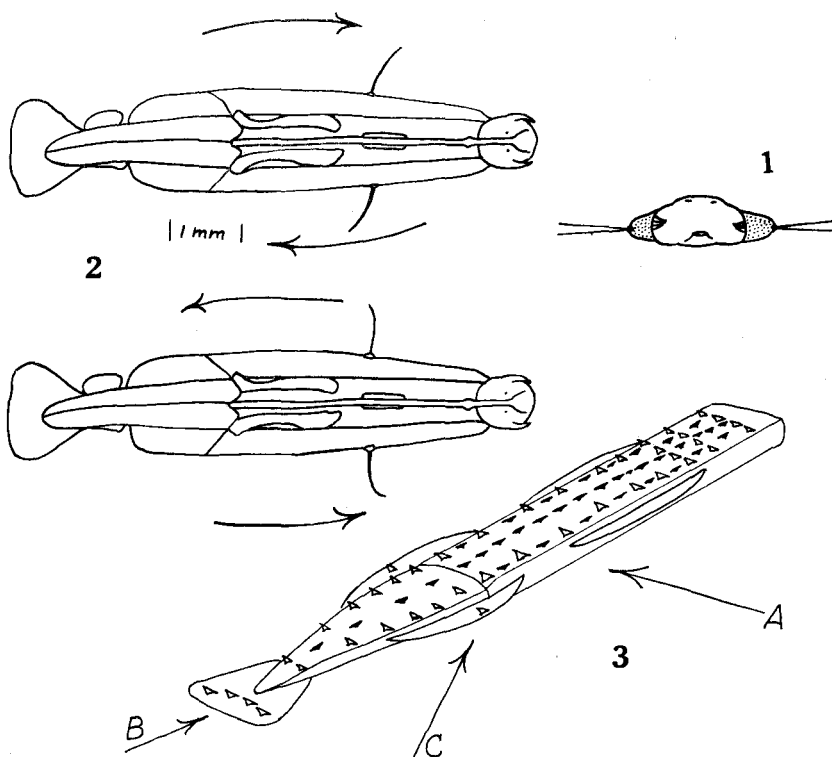


Fig. 1. Schematic drawing of head on view of *Pterosagitta draco* showing "V" shape of the "wings" in a living specimen.

Fig. 2. Dorsal view of *Pterosagitta draco* showing bending of the "wings" when the container is rotated in the direction of the arrows.

Fig. 3. Schematic drawing of the arrangement of the tufts on the dorsal surface of *Aidanosagitta regularis*, based on AIDA (1897). The open triangles are longer fan-shaped tufts arranged transversely to the long body axis. The closed triangles are shorter fan-shaped tufts arranged with the "fan" parallel to the long axis of the arrowworm. Vibrations from A would affect the shorter tufts more strongly, while vibrations from B would have a greater effect on the longer tufts. Vibrations from C would give an intermediate effect. The arrangement of the tufts on the ventral side is different from the dorsal side.

Arrangement of the "Wings" in Living *Pterosagitta*

The wings are rarely seen in preserved specimens of *P. draco* for two reasons. First, the "wings" and large parts of the collarete, if not all of the collarete, are frequently abraded off in coarse mesh plankton nets, as reported by MICHAEL (1919). Secondly, some kind of chemical decomposition of the shorter tufts and longer "wings" occurs when chaetognaths are preserved in either acidic or basic formalin. After several days in the preservative, the "wings" disappear except for the basal supporting mound.

Thus the "wings" are not often seen.

HERTWIG (1880, see reproduction in HYMAN, 1959) shows the "wings" of *P. draco* from the dorsal view. According to my observations this figure is incorrect in showing the "wings" inclined at an angle to the long axis of the body. AIDA (1897) shows the "wings" inclined forward, while VANNUCCI and HOSOE (1952) in their detailed figure of *Pterosagitta besnardi*, a synonym of *P. draco*, do not show the long "wings" although the basal mound opposite the ventral ganglion is shown clearly. Judging from the variety shown in the literature, it seems that the orientation of the "wings" may be distorted on preservation. In the live specimen observed on October 24, the "wings" were perpendicular to the long body axis. HERTWIG's figure also shows the "wings" much thicker than in the live specimen. Although the length in his figure is about right, the "wings" are about one-half to one-third as wide as he shows. Perhaps more important is the fact that in the living animal each "wing" is divided into two thin bundles. From a head on view, the "wings" on each side of the voluminous collarette diverge from the point of attachment to form a "V". The angle of the "V" is about ten degrees (Fig. 1).

Possible Function of the "Wings" and Tufts

Anyone who has tried to catch a live chaetognath with a glass pipette knows how skillful they are at escaping underwater objects. The primitive chaetognath eye is not capable of image formation (BURFIELD 1927). The detection of transparent objects in the water must be due to a mechanical sensor. This is indicated by the following observation. *Sagitta* responds very quickly to a glass rod moved towards it in the water, but it does not respond to the same rod moved just above it but out of the water. Apparently chaetognaths have some sensory system based on water flow or wave motion or both. They are particulate feeders on small, active, largely transparent copepods and must have a highly directional, short period pressure sensor. Such a sensing system would also help them to evade predators. The longitudinal rows of tufts might serve this function.

In order to see the live specimen of *Pterosagitta draco* more clearly, I placed it in a small stoppered vial and rocked the vial back and forth in an attempt to move the specimen about. However, the arrowworm took up a position in the center of the vial and remained in a horizontal attitude despite rather rapid rocking of the vial. The "wings" bent or swayed in response to the water motion. Even the gentlest twist or slightest movement of the vial caused the "wings" to bend. In this case the "wings" bent in contra-rotation to each other (Fig. 2). The bending of the "wings" did not evoke any visible response in the arrowworm.

From these elementary observations it seems possible that the sensory tufts of chaetognaths might well function as detectors of water motion. The basic mechanism is a distortion of the shape and position of the tufts due to the inertia of the body of the chaetognath and the flexibility of the tufts. By their arrangement in long rows down the length of the body, they could also function to detect low frequency vibrations in the water in a manner analagous to the lateral line of fishes. GRASSI (1883) reported, and AIDA (1897) confirmed, that the tufts are of two kinds, longer ones shaped like a fan and arranged transversely to the long body axis, and shorter ones, also shaped like a fan arranged longitudinally or parallel to the long body axis. In this arrangement observed by AIDA in eight species in several genera, the shorter fans would be more distorted by lateral vibrations and the longer fans more distorted by longitudinal vibrations. The arrangement of the tufts figured by AIDA (1897) in *Aidanosagitta regularis* is shown schematically in Figure 3. It could permit directional detection of vibrations as well as discrimination of different frequencies. The "V" shaped "wings" of *Pterosagitta draco* appear to be an elaboration of the shorter tufts and may represent a variably tuned receptor capable of distinguishing different frequencies. In any case it seems evident that the tufts and "wings" are not tactile receptors as commonly reported in the literature.

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